(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 763 654 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.03.1997 Bulletin 1997/12

(51) Int. Cl.[6]: F02K 1/76

(21) Application number: 95402068.1

(22) Date of filing: 13.09.1995

(84) Designated Contracting States:
DE ES FR GB

(71) Applicant: SOCIETE DE CONSTRUCTION DES AVIONS
HUREL-DUBOIS
(société anonyme)
F-92360 Meudon-La-Forêt (FR)

(72) Inventor: Fournier, Alain
F-92350 Le Plessis Robinson (FR)

(74) Representative: Sauvage, Renée
Cabinet Sauvage
100 bis, avenue de Saint-Mandé
75012 Paris (FR)

(54) Electro/hydraulic system for a 2 door thrust reverser

(57) A thrust reverser for a turbo-fan engine having an improved system for security against inflight inadvertent deployment.

The reverser has two pivoting doors (1,2) for use on engines mounted on an aircraft rear fuselage or under the aircraft wing.

The pivoting doors (1,2) are positioned forward of an aft ring structure (3) that is essentially the nacelle exit nozzle in forward thrust mode.

The pivoting doors (1,2) are actuated by a hydraulic actuator and are locked and unlocked by hook locks (9,8) operated by an electric solenoid on one side of the door and a small hydraulic actuator on the opposite side.

The two locking systems are completely independent, thereby assuring that an inadvertent in-flight deployment will not occur as a result from failure, faulty command or maintenance malpractice.

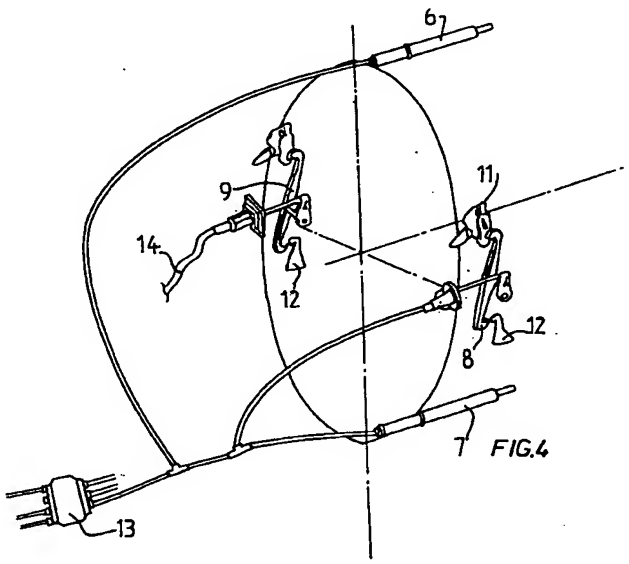

FIG.4

EP 0 763 654 A1

Description

This invention relates to a thrust reverser for turbo-fan engines used on aircraft. More particularly this invention relates to an improved system that assures an in-flight inadvertent deployment will not occur.

For turbo-fan engines the thrust reverser is provided to reduce the stopping distance of the aircraft and to increase safety when landing on a wet or icy runway.

This invention applies particularly to thrust reversers comprised of two pivoting doors that pivot about axes, from a stowed position to a deployed position. When deployed the doors block the flow of one or both flows and eject the flow in a forward direction.

The reverser is only intended for ground use, and because of the effect of the reverse thrust propulsion forces, in-flight deployment can result in aircraft instability and loss of controllability.

In order to obtain added security against in-flight faulty command, maintenance malpractice or deployment due to failures, improved system locking must be developed to provide additional margins of safety.

The primary object of this invention is to provide positive locking through at least two independent systems which will thereby prevent any inadvertent in-flight deployment.

On prior art relating to thrust reverser systems, two typical pivoting door reversers are described by FAGE in US-4.422.605 (FR-A-2.494.775) and US-4.424.669 (FR-A-2.500.537).

Other similar designs are disclosed by LAIR in US-5.224.342 and FAGE again in US-5.310.117. For these particular thrust reversers, the locking mechanism is comprised of two hooks per door, released by a hydraulic actuator on each side of the door.

The pivoting doors are deployed and stowed by a large hydraulic actuator installed on one side of the two doors. Thrust reversers of this known type are illustrated in figure 1.

The aforementioned designs have control systems where the main actuator and the two separate hook locks are hydraulically actuated through a common line and selector valve.

A disadvantage of the prior art described, resides in the fact that a faulty command or a maintenance error can result in an in-flight deployment. It has been experienced on recent incidents that a pressure build up due to a hydraulic leak can result in a system command to the deploy mode, without pilot permission. The way to prevent this is to have two independent locking systems. One being commanded hydraulically by the engine control system, and the other going to the cockpit to be pilot electrically controlled.

Another cause of an inadvertent deployment is the eventual loss of a pivoting door, by a failure of the door pivot bolt or fitting. The aforementioned design, which has the pivot bolt fitting integrated into the main actuator, does not provide the safety requirements of the certification agencies, in that the pivoting door could break loose as a result of buffeting if the pivot bolt failed, or if a bolt was poorly installed due to maintenance malpractice.

Other examples of prior art are disclosed by STAVERT in US-2.780.057 and MATHIAS in US-5.120.004, and CRIFFIELD in GB-921.917. These known control systems rely on hooks and mechanical linkages that are actuated through a common supply line and selector valve. The door and pivot bolts are located at the exit nozzle with no aft ring that entraps the rear of the doors. The prior art of CRIFFIELD is illustrated by Figure 2, and the hook referred to as H.

Therefore these said systems do not provide the adequate safety required for modern aircraft.

In FR-A-2.601.077, KENNEDY describes a pivoting door reverser, that is forward mounted, with an aft ring exit nozzle.

This design is an improvement, but still has the main actuator for deploy and stow, and two separate hook locks, all actuated through a common supply line and hydraulic selector valve. Therefore, a need for improved safety is required.

This invention will protect against the aforementioned disadvantages by offering a design that combines three basic principles.

The first is to position the main actuator in the center of the door, with a safety lock integrated.

The second is to have two independent locking systems, one being hydraulic, the other being electric on each door.

The third is to have an aft ring exit nozzle that entraps the rear portion of the pivoting door during the stow or cruise mode. This is illustrated in Figures 8 and 9.

This invention will overcome the above described problems by providing an improved system for security against in-flight inadvertent deployment.

More particularly, the invention provides a thrust reverser for a turbo-fan engine with mixed hot and cold airflow, said thrust reverser being mounted on the aft fuselage of an aircraft and comprising ;

- an engine casing having lateral beams and two radially spaced openings, one being above, the other being below the engine axis ;
- two thrust reversing pivoting doors, installed in the casing openings, pivotally mounted by two axis supported by the casing lateral beams, said doors being movable from a stowed position in which they do not interfere with the mixed airflow to a deployed position in which they block the mixed airflow and direct it in a forward direction ;
- a hydraulically actuated pivoting door actuator attached to the center of each pivoting door for moving the said door from said stowed position to said deployed position,
- a hydraulically actuated piston driven S-hook lock on one side of the doors, that retains the pivoting doors in the stowed position, and

- an electrical solenoid operated S-hook lock on the opposite side of the pivoting doors.

Contained within the actuator, is a snubbing mechanism that prevents the said doors from butting against each other when in the deployed position.

Preferably, two pivoting doors are located forward of an aft ring exit nozzle. Each door is deployed and stowed by its own hydraulic actuator positioned in the center of the door. The actuator is controlled by the hydraulic selector valve which receives its commands from the engine electronic control unit.

In the forward thrust position the two pivoting doors are locked in position by four hook locks. Each door has two hook locks, sometimes referred to as S-hooks. These hook locks are shaped like an S with a pivot point in the center. One S-hook can thereby latch two doors.

The hook locks are released simultaneously, by two independent circuits. The right side is released by a hydraulic actuator in the circuit of the hydraulic selector valve and the engine electronic control unit. The left side S-hook is released by a solenoid energized by an electric circuit from the cockpit.

A system of electrical switches and transducers is provided to indicate correct or incorrect functioning of the reverser system to the pilot and to the engine control system.

In the drawings :

Figure 1 is a perspective view of a known two door type reverser with two locks per door.
Figure 2 is a perspective View of a known two door type reverser with one lock per door
Figure 3 is a perspective view of the thrust reverser corresponding to the present invention.
Figure 4 is a perspective view of the thrust reverser isolated system components.
Figure 5 is a partial perspective view of the S-hook lock installation.
Figure 6 is a side view of the S-hook lock and hydraulic piston actuation.
Figure 7 is a side view of the S- hook lock and pivoting door latch.
Figure 8 is a perspective view of the thrust reverser assembly.
Figure 9 is a side view detailing the safety catch that prevents the door from departing from the aft ring structure.

Referring to Figure 1 there is seen a typical two door thrust reverser for a turbofan engine. It is clearly shown that the main actuator 6 is located on the lateral side and this actuator along with the two hook locks 8 per door 1,2 are all actuated through a common supply line L.

It is also shown in this prior art that there is no aft ring structure aft of the pivoting door trailing edge.

Referring to Figure 2 there is seen another known two door reverser, with only one hook lock H per door 1,2.

It is also shown in this prior art that there is no aft ring structure aft of the pivoting door trailing edge.

Referring now to Figure 3 we see the thrust reverser corresponding to the present invention. This reverser is comprised of an upper pivoting door 1 and a lower pivoting door 2, installed in corresponding openings O provided in the casing, and an aft ring structure 3 which is essentially the nacell exit nozzle in forward thrust mode. This aft ring structure is attached to the two side beams 4.

The two pivoting doors 1,2 pivot around the pivot axes 5, through fittings installed in the side beams 4.

The actuation system is comprised of an upper door main actuator 6 and a lower door main actuator 7 (Figure 4). These actuators are located on the vertical center line of the thrust reverser and are attached to the center of the doors.

Two independent S-hook locks 8,9 (Figure 4) are installed in the side beams 4, to lock the pivoting doors 1,2 in the stow position.

The left side S-hook lock 8 is hydraulically actuated by the same circuit as the main pivoting door actuator 7. The right side S-hook lock 9 is operated by an electric solenoid energized from the pilot 14 and independent from the S-hook lock 8 that is actuated through the hydraulic selector valve 13 and the engine electronic control system.

A system of electrical switches and transducers is provided to indicate correct functioning of the reverser systems to both the pilot and the engine electronic control system.

The stow switch 10 is shown on Figure 3 ; when the door is unlocked this switch 10 gives an unlock indication to the pilot 14.

Figures 5, 6 and 7 show additional details of the S-hook locks. The upper and lower pivoting door latches, respectively 11 and 12, are also shown. It can be seen that the hooks on both sides of the doors are a single piece unit that engages both the upper door latch 11 and lower door latch 12 simultaneously.

In Figures 8 and 9 the pivoting door aft catch fitting 15 is shown interlocking with the aft ring structure catch fitting 16.

The catch fitting 15 and 16 entrap the rear portion of the pivoting door, during stow mode in the event of a pivot bolt or fitting failure.

Thus, the described thrust reverser system can be seen to improve the security against inadvertent in-flight deployment.

Claims

1. A thrust reverser for a turbo-fan engine with mixed hot and cold airflow, said thrust reverser being mounted on the aft fuselage of an aircraft and comprising ;

   - an engine casing having lateral beams (4)and

two radially spaced openings (O), one being above, the other being below the engine axis ;

- two thrust reversing pivoting doors (1,2), installed in the casing openings (O), pivotally mounted by two axis supported by the casing lateral beams (4), said doors being movable from a stowed position in which they do not interfere with the mixed airflow to a deployed position in which they block the mixed airflow and direct it in a forward direction ;
- a hydraulically actuated pivoting door actuator attached to the center of each pivoting door for moving the said door from said stowed position to said deployed position,
- a hydraulically actuated piston driven S-hook lock (8) on one side of the doors, that retains the pivoting doors in the stowed position, and
- an electrical solenoid operated S-hook lock (9) on the opposite side of the pivoting doors.

2. The thrust reverser in accordance to claim 1, characterized in that a snubbing mechanism, that prevents the said doors (1,2) from butting against each other when in the deployed position, is contained in said actuator.

3. The thrust reverser in accordance to claim 1, with two pivoting doors (1,2) installed forward of an aft ring exit nozzle structure (3), with a safety catch (15) fitting on the rear of the pivoting door, interlocking with a safety catch (16) fitting on the aft ring structure, to entrap the rear part of the said door in the event of a structural attachment failure or in the event of maintenance malpractice during installation of the said door and pivot bolt.

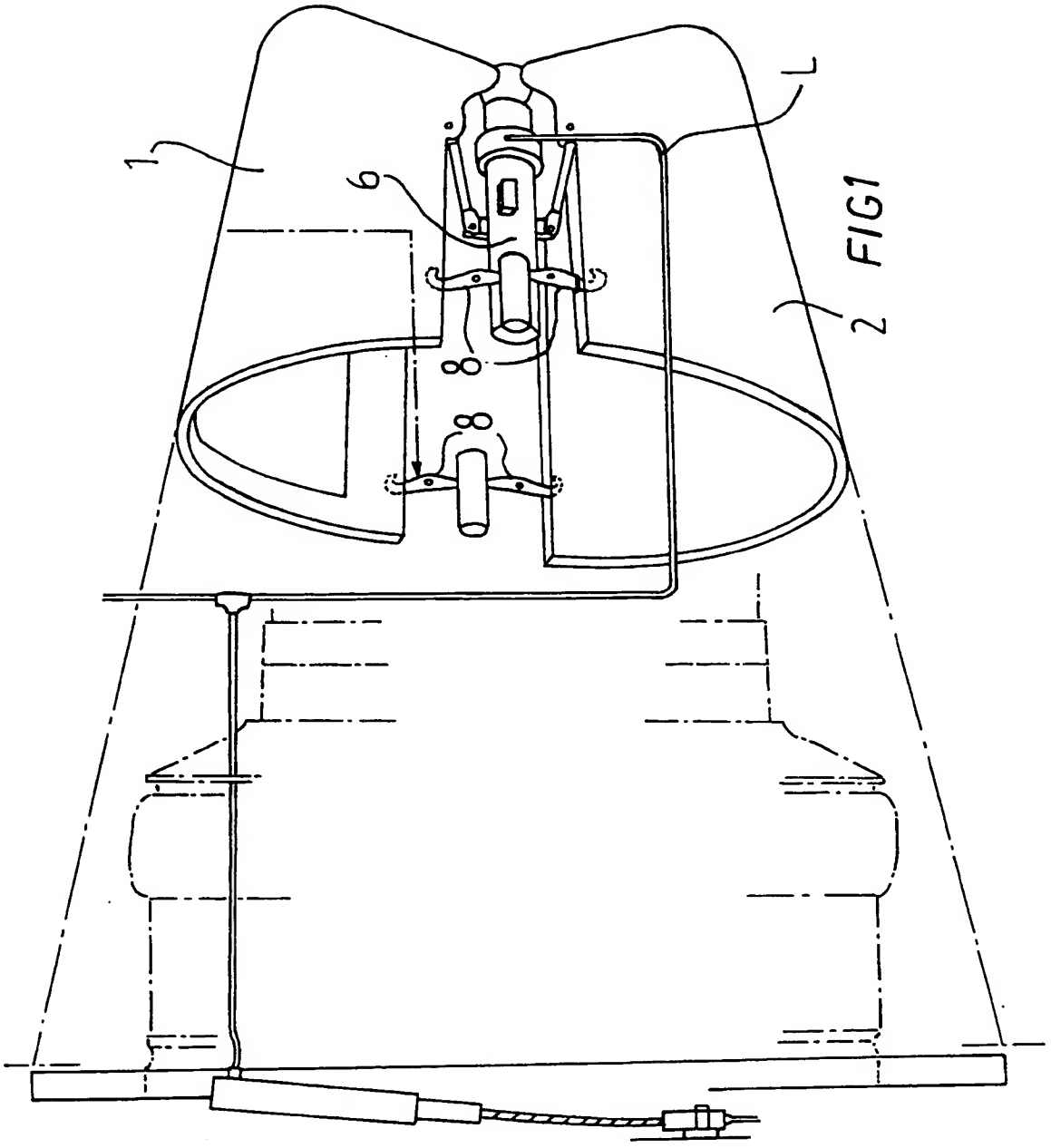

FIG1

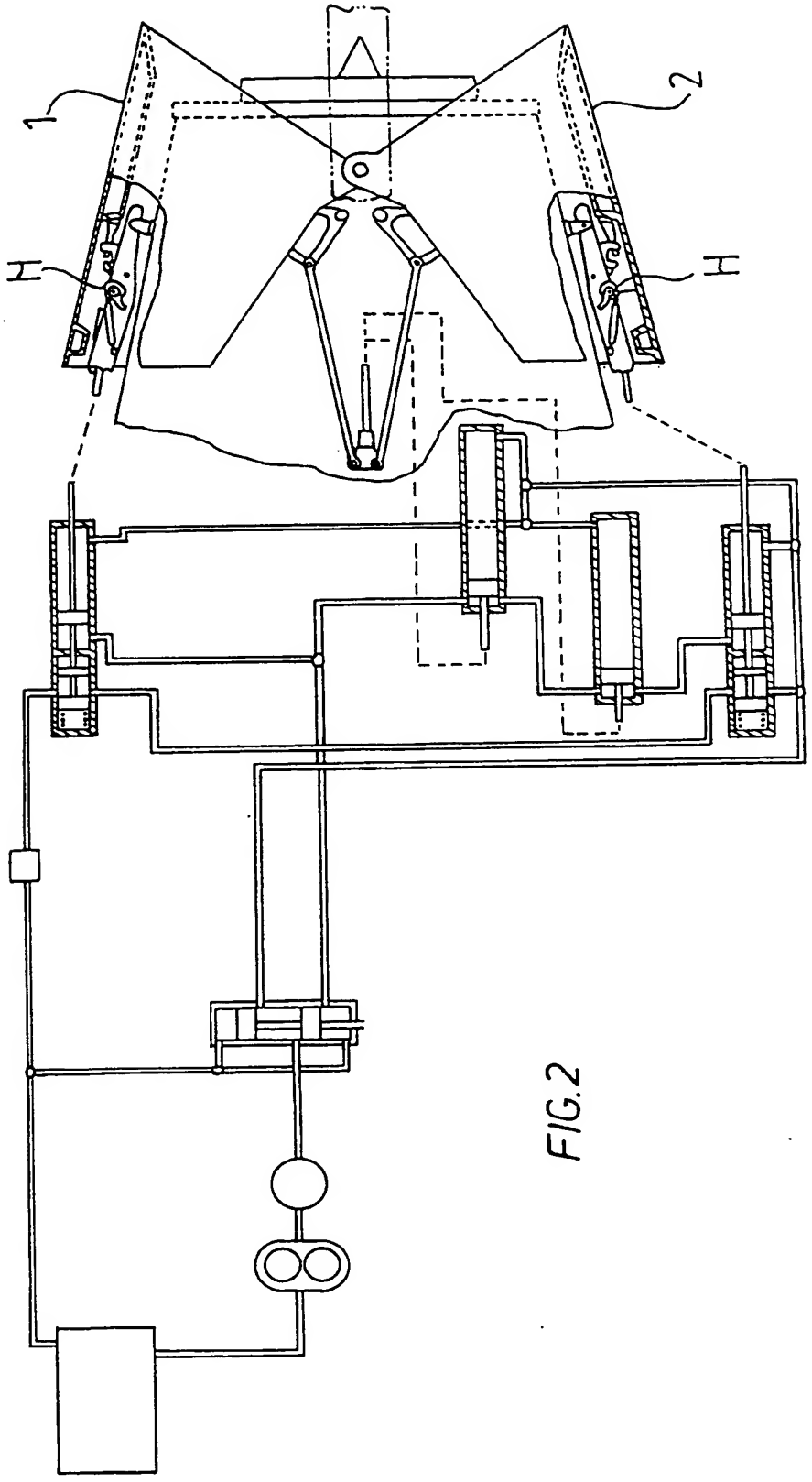

FIG.2

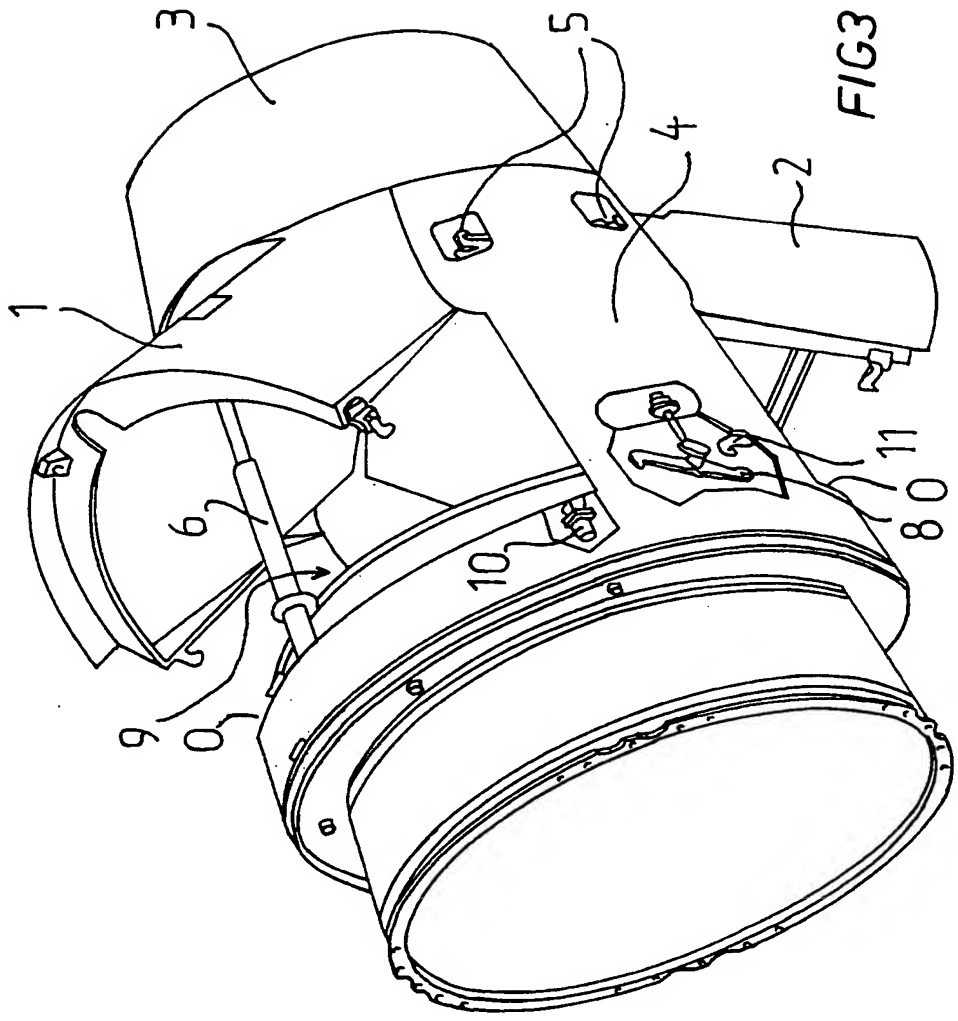

FIG3

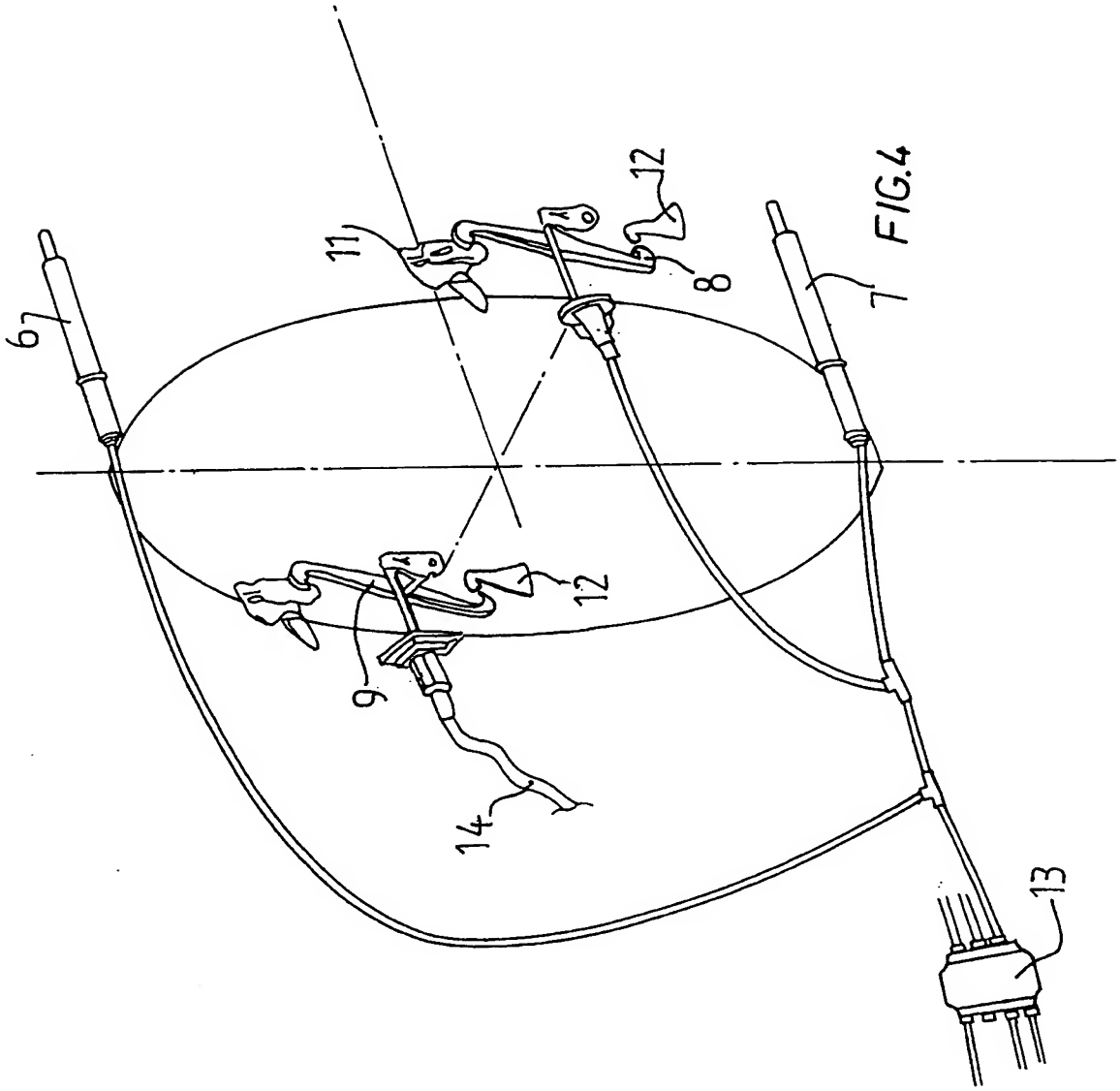

FIG.4

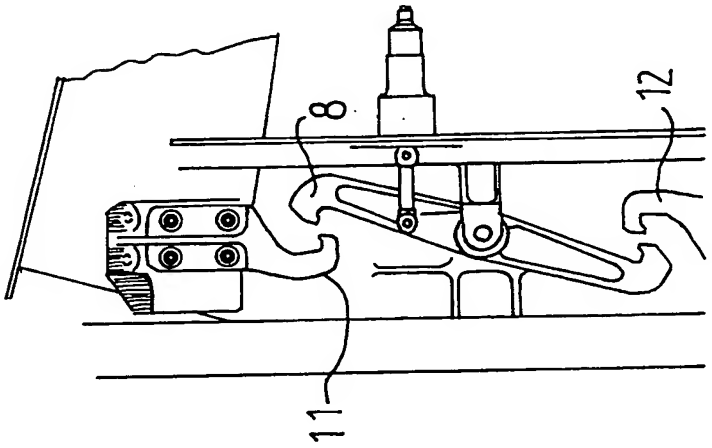

FIG7

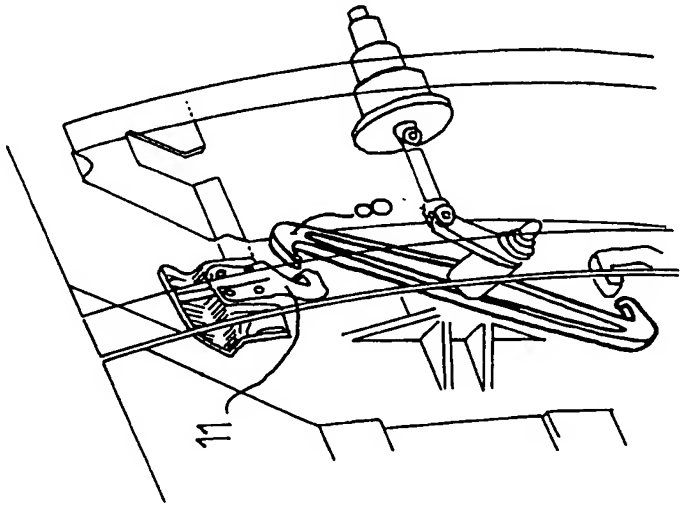

FIG6

FIG5

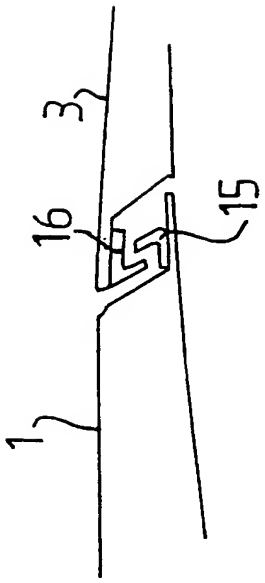

FIG9

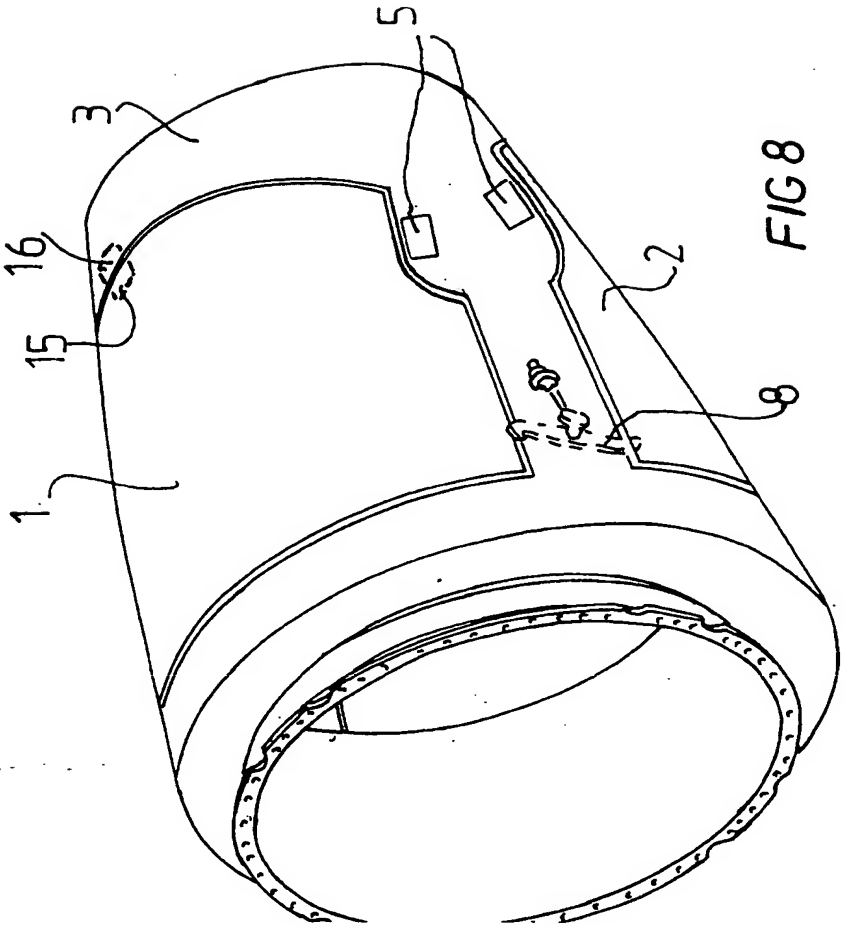

FIG8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 40 2068

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 542 611 (HUREL DUBOIS AVIONS) 19 May 1993 * column 3, line 9 - column 4, line 7 *	1	F02K1/76
X	EP-A-0 646 718 (LUCAS IND PLC) 5 April 1995 * column 3, line 34 - column 4, line 15 * * column 5, line 33 - line 38 *	1	
Y	EP-A-0 175 599 (HUREL DUBOIS AVIONS) 26 March 1986 * figures 3,4 *	1	
Y	GB-A-782 679 (BRISTOL AERO-ENGINES LTD) 21 May 1954 * page 8, line 59 - page 9, line 64; figure 6 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F02K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 February 1996	Argentini, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)